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VIDEO SIGNAL REPRODUCTION APPARATUS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

The present invention relates to a video signal reproduction apparatus for reproducing, as a progressive scan video signal, a video signal recorded in tape media, disk media, and the like, or a video signal carrying various image information such as movie materials or video materials through satellite broadcast, ground-based broadcast, and the like.

2. DESCRIPTION OF THE RELATED ART:

Conventionally, video signals recorded in tape or disk media, or video signals transmitted through satellite broadcast, cable broadcast, or ground-based broadcast are commonly output as interlaced scan video signals by video signal reproduction apparatuses so that the video signals can be reproduced by image receivers. Recently, video signal reproducing apparatuses for converting interlaced scan video signals into progressive scan video signals are being introduced as monitors and projectors compatible with multi-scanning, or monitors for computers are becoming widespread.

The term "aspect ratio" as used herein refers to a ratio of the horizontal size of an image to the vertical size of the image as well as a ratio of the horizontal size of a monitor screen displaying an image to the vertical size of the monitor screen.

Figure **12** is a block diagram showing a configuration of a conventional video signal reproducing apparatus **1200** which reproduces an information signal recorded in a

disk-type medium. In Figure 12, reference numeral 1 denotes a disk on which an information signal is recorded in an encoded and modulated signal form suitable for recording (or reproducing) in advance. The information signal includes a video signal and a determination flag indicating the type of the video signal.

The video signal reproducing apparatus 1200 includes: a pickup 2 for transforming an information signal recorded on the disk 1 to an electrical signal; a disk rotating apparatus 3 for rotating the disk 1 at a certain revolution-per-minute suitable for the disk 1; a material determination circuit 5 for determining the type of a video signal based on the determination flag included in the information signal; a converter 101 for converting the electrical signal transformed by the pickup 2 to an interlaced scan video signal and a progressive scan video signal; an encoder 7 for converting the interlaced scan video signal into an NTSC video format and outputs the result through an interlaced scan video output terminal 8 to an interlaced scan video monitor 103; and a color difference converter 10 for converting the progressive scan video signal output from the converter 101 into an analog color difference signal and outputs the result through a progressive scan video output terminal 11 to a progressive scan video monitor 104.

The converter 101 includes: an interlaced scan video signal reproduction circuit 4 for demodulating and decoding the electrical signal output from the pickup 2 and outputting the resultant signal as an interlaced scan video signal; an interlaced scan aspect ratio conversion circuit 6 for converting the aspect ratio of the interlaced

scan video signal and outputs the result; an interlaced scan aspect ratio designating section **13** which is used by a user to designate the aspect ratio of the interlaced scan video monitor **103**; an interlaced scan control circuit **12** for controlling the interlaced scan aspect ratio conversion circuit **6** based on the video signal type determined by the material determination circuit **5** and the type of the interlaced scan video monitor **103** designated by the interlaced scan designating section **13**, and a progressive scan video signal conversion circuit **9** for converting the interlaced scan video signal having the converted aspect ratio into a progressive scan video signal and outputting the result.

The operation of the conventional video signal reproduction apparatus thus constructed will be described with reference to Figures **13** through **21**.

Figure **13** is a schematic diagram showing the structure of a video signal reproduced from the disk **1**. In an interlaced scan video signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The scan lines of the two field are alternately arranged. In other words, a pixel of one field is disposed between two adjacent pixels of the other field in the vertical direction. In a progressive scan video signal, one frame is created in 1/60 second and the number of pixels of one frame in the vertical direction is 480. Both have a vertical frequency of 1/60 second. The number of horizontal scan lines of the progressive scan video signal is twice as many as that of the interlaced scan video signal. The horizontal scan frequency of the interlaced scan video

signal is about 15.75 KHz, while that of the progressive scan video signal is double, i.e., about 31.5 KHz.

Figure **14A** is a schematic signal diagram showing the structure of the video signal reproduced from the disk **1**. As shown in Figure **14A**, the video signal reproduced from the disk **1** has three forms. A first form of video signal represents an image having information which fills a full screen of 4:3 (hereinafter referred to as a 4:3 full image **301**). A second form of video signal represents an image of 16:9 in the middle of the 4:3 screen, the upper and lower portions of the screen being shaded (hereinafter referred to as a 4:3 letterbox image **302**). A third form of video signal represents an image having information which fills a full screen of 16:9 (hereinafter referred to as a 16:9 full image **303**).

Figure **14B** shows the aspect ratio of the interlaced scan video monitor **103**. As shown in Figure **14B**, there are two types of monitors for the interlaced scan video monitor **103**, one monitor **304** having an aspect ratio of 4:3 and the other monitor **305** having an aspect ratio of 16:9.

Figure **14C** shows the aspect ratio of the progressive scan video monitor **104**. As shown in Figure **14C**, there are two types of monitors for the progressive scan video monitor **104**, one monitor **306** having an aspect ratio of 4:3 and the other monitor **307** having an aspect ratio of 16:9.

The interlaced scan video signal reproduction circuit **4** reads a video signal recorded on the disk **1** from an output of the pickup **2**, reproduces an interlaced scan video signal, and outputs the result to the interlaced scan

aspect ratio conversion circuit **6**. The material determination circuit **5** reads the determination flag from an output of the pickup **2**, determines the type of the video signal, and outputs the result as a determination signal to the interlaced scan control circuit **12**.

A user designates the type (aspect ratio) of the interlaced scan video monitor **103** through which the user intends to output an interlaced scan video signal, using the interlaced scan aspect ratio designating section **13**. The interlaced scan control circuit **12** controls the interlaced scan aspect ratio conversion circuit **6** based on a determination signal output from the material determination circuit **5** and the type (aspect ratio) of the interlaced scan video monitor **103** designated by the interlaced scan aspect ratio designating section **13**.

Figure **15** is a schematic diagram for explaining the operation of the interlaced scan aspect ratio conversion circuit **6**. Assuming that the interlaced scan video monitor **103** has an aspect ratio of 4:3, the interlaced scan aspect ratio conversion circuit **6** has a function which compresses the 16:9 image **303** having an aspect ratio of 16:9 in the vertical direction. Specifically, in order to display the 16:9 image **303** on the 4:3 monitor **304** at the correct aspect ratio, 4 lines of information of an input video signal are subjected to a filtering process so that 3 lines of information are generated. Such a process is performed for the entire screen, so that the entire screen is compressed in the vertical direction. In this case, the displayed image has a correct aspect ratio (16:9), but leaving blanks in the upper and lower portions. Such portions are rendered black images. This aspect ratio

conversion function can switch between a working state and a non-working state using the interlaced scan control circuit **12**. In the case of the non-working state, the interlaced scan aspect ratio conversion circuit **6** outputs a received interlaced scan video signal without the aspect ratio conversion.

In Figure **12**, the user designates as the type (aspect ratio) of the 16:9 image **303**, through which the user intends to output an image, the monitor **304** having an aspect ratio of 4:3 or the monitor **305** having an aspect ratio of 16:9 using the interlaced scan aspect ratio designating section **13**. The material determination circuit **5** outputs the aspect ratio of an image source, i.e., one of the 4:3 full screen **301** or the 4:3 letterbox screen **302**, and the 16:9 screen **303**, to the interlaced scan control circuit **12**. The interlaced scan control circuit **12** causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the non-working state when the material determination circuit **5** indicates that the type of an image source is the 4:3 full image **301** or the 4:3 letterbox image **302**. The interlaced scan control circuit **12** causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the non-working state when the material determination circuit **5** indicates that the type of the image source is the 16:9 image **303** and the interlaced scan aspect ratio designating section **13** designates the monitor **305** having an aspect ratio of 16:9. Note that the interlaced scan control circuit **12** causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the working state when the material determination circuit **5** indicates that the type of the image

source is the 16:9 image **303** and the interlaced scan aspect ratio designating section **13** designates the monitor **304** having an aspect ratio of 4:3.

The encoder **7** converts an output of the interlaced scan aspect ratio conversion circuit **6** to the NTSC video format. The encoder **7** outputs an interlaced scanned image having the NTSC video format through the interlaced scanned image output terminal **8** to the interlaced scan video monitor **103**.

Figures **16A** through **16C** are schematic diagrams for explaining the 4:3 full image displayed on an interlaced scan video monitor. As shown in Figure **16A**, the 4:3 full image **301** displayed on the 4:3 interlaced scan video monitor**304** has the correct aspect ratio. However, a 4:3 full image **301A** displayed by the 16:9 interlaced scan video monitor **305** does not have the correct aspect ratio, so that the displayed image is extended horizontally as shown in Figure **16B**. The 16:9 interlaced scan video monitor **305** includes a 4:3 output switch function since the standard aspect ratio of an interlaced scan video signal is 4:3. As shown in Figure **16C**, the 16:9 interlaced scan video monitor **305** can display a 4:3 full image **301B** having the correct 4:3 aspect ratio using the 4:3 output switch function.

Figures **17A** through **17D** are schematic diagrams for explaining the 4:3 letterbox image displayed on an interlaced scan video monitor. As shown in Figure **17A**, the 4:3 letterbox image **302** displayed on the 4:3 interlaced scan video monitor **304** has the correct aspect ratio. However, as shown in Figure **17B**, the 4:3 letterbox image **302A**

displayed on the 16:9 interlaced scan video monitor **305** does not have the correct aspect ratio, so that the displayed image is extended horizontally. The interlaced scan video monitor includes a 4:3 letterbox image output switch function since the standard aspect ratio of interlaced scan video signal is 4:3. With the 4:3 letterbox output switch function, as shown in Figure **17C**, the 4:3 letterbox image **302A** is extended both upward and downward so that a 4:3 letterbox image **302B** fills the full screen. Therefore, the interlaced scan video monitor **305** can display a 4:3 letterbox image at a correct aspect ratio of 16:9. An image source may have subtitle information **302C** at the lower blank portion of an image. In this case, when a 4:3 letterbox image **(302A)** is extended upward and downward so that the 4:3 letterbox image **(302B)** fills a full screen and is displayed at a correct aspect ratio of 16:9, the subtitle information **302C** disappears. To avoid such a situation, the interlaced scan video monitor **305** has a switch function with which the subtitle information **302** is shifted upward to be viewed on the screen.

Figures **18A** through **18C** are schematic diagrams for explaining a 16:9 image displayed on an interlaced scan video monitor. As shown in Figure **18A**, when a 16:9 image **303A** is displayed as it is on the 4:3 interlaced scan video monitor **304**, the image does not have the correct aspect ratio, such that the displayed image is extended vertically. However, if the user teaches the interlaced scan aspect ratio designating section **13** that an interlaced scan monitor to be connected to the apparatus **1200** is the 16:9 interlaced scan monitor **305**, the interlaced scan aspect ratio conversion circuit **6** is activated and the aspect ratio is converted so that an image (16:9 image **303B**) is correctly

displayed as shown in Figure **18B**. In addition, as shown in Figure **18C**, the 16:9 interlaced scan video monitor **305** displays a 16:9 image **303** at a correct aspect ratio of 16:9.

Specifically, in the conventional video signal reproduction apparatus **1200**, the interlaced scan video monitor can display images having a correct aspect ratio in any combination of 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types of video monitors, i.e., the 4:3 monitor and the 16:9 monitor.

An output of the interlaced scan aspect ratio conversion circuit **6** is input to the progressive scan video signal conversion circuit **9**. The progressive scan video signal conversion circuit **9** converts an input interlaced scan video signal to a progressive scan video signal, and outputs the result. The color difference converter **10** converts the progressive scan video signal to a color difference video signal, and outputs the progressive scan video output through the progressive scan video output terminal **11** to the progressive scan video monitor **104**.

Figures **19A** and **19B** are schematic diagrams for explaining a 4:3 full image displayed on a progressive scan video monitor. As shown in Figure **19A**, the 4:3 full image **301** displayed on the 4:3 progressive scan video monitor **306** has the correct aspect ratio. However, as shown in Figure **19B**, a 4:3 full image **301C** displayed on the 16:9 progressive scan video monitor **307** does not have the correct aspect ratio, so that the displayed image is extended horizontally. Here, the 16:9 progressive scan video monitor is a monitor intended to receive a high-definition

television signal, and has a standard aspect ratio of 16:9 but does not include a 4:3 output mode. Therefore, a 4:3 full image is not displayed at the correct aspect.

Figures **20A** and **20B** are schematic diagrams for explaining a 4:3 letterbox image displayed on the progressive scan video monitor. As shown in Figure **20A**, the 4:3 letterbox image **302** displayed on the 4:3 progressive scan video monitor **306** has the correct aspect ratio. However, as shown in Figure **20B**, a 4:3 letterbox image **302C** displayed on the 16:9 progressive scan video monitor **307** does not have the correct aspect ratio, so that the displayed image is extended horizontally. As described above, the 16:9 progressive scan video monitor **307** is a monitor intended to receive a high-definition television signal, and has a standard aspect ratio of 16:9 but does not include a 4:3 output mode. Therefore, a 4:3 full image is not displayed at the correct aspect.

Figures **21A** through **21C** are schematic diagrams for explaining a 16:9 image displayed on an interlaced scan video monitor. As shown in Figure **21A**, when a 16:9 image **303C** is displayed as it is on the 4:3 progressive scan video monitor **306**, the image does not have the correct aspect ratio, such that the displayed image is extended vertically. However, if the user teaches the interlaced scan aspect ratio designating section **13** that a progressive scan video monitor to be connected to the apparatus **1200** is the 16:9 interlaced scan monitor **307**, the interlaced scan aspect ratio conversion circuit **6** is activated and the aspect ratio is converted so that an image (16:9 image **303D**) is correctly displayed as shown in Figure **21B**. In addition, as shown in Figure **21C**, the 16:9 progressive scan video monitor **307**

displays a 16:9 image **303** at a correct aspect ratio of 16:9.

As described above, in the conventional video signal reproduction apparatus **1200**, there is a problem in that a 4:3 full image and a 4:3 letterbox image cannot be displayed on a 16:9 video monitor at the correct aspect ratio.

Further, when a 4:3 letterbox image includes a subtitle at a lower portion of the screen, there is a problem in that if the 4:3 letterbox image is extended upward and downward so as to be displayed at the correct ratio on a 16:9 video monitor, the subtitle disappears.

Accordingly, there is a demand for a video signal reproduction apparatus in which in any combination of 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types video monitor, i.e., the 4:3 monitor and the 16:9 monitor, any image can be displayed at the correct aspect ratio. Even when the 4:3 letterbox image includes a subtitle at a lower portion of the screen, the disappearance of the subtitle needs to be prevented.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, a video signal reproduction apparatus is provided for receiving an information signal including a video signal and a determination signal indicating a type of the video signal, and reproducing the video signal included in the information signal. The apparatus comprises a conversion section for converting the video signal to a progressive scan video signal, and an aspect ratio conversion section

for converting an aspect ratio of the progressive scan video signal output from the conversion section and outputting the converted progressive scan video signal to a progressive scan video monitor. The aspect ratio conversion section converts the aspect ratio of the progressive scan video signal based on the determination signal indicating the type of the video signal and monitor information indicating a type of the progressive scan video monitor.

In one aspect of this invention, the aspect ratio conversion section converts the aspect ratio of the progressive scan video signal so that the progressive scan video signal is displayed on the progressive scan video monitor at a correct aspect ratio.

In one aspect of this invention, the aspect ratio includes first and second aspect ratios, the video signal includes a video signal representing a first image having the first aspect ratio and a second image having the second aspect ratio, the progressive scan video monitor includes a first monitor having the first aspect ratio and a second monitor having the second aspect ratio, and the aspect ratio conversion section converts the aspect ratio of the progressive scan video signal when the determination signal indicates the first image as having the first aspect ratio and the monitor information indicates the second monitor as having the second aspect ratio.

In one aspect of this invention, the first image includes a full image having the first aspect ratio, the aspect ratio conversion section converts the aspect ratio of the progressive scan video signal so that the full image represented by the progressive scan video signal is

compressed in a horizontal direction, when the determination signal indicates the full image.

In one aspect of this invention, the second monitor having the second aspect ratio extends the full image having the first aspect ratio in a horizontal direction by a factor of (M/N) where M and N are integers and M>N. The aspect ratio conversion section compresses the full image in the horizontal direction by a factor of (N/M) so that the full image having the first aspect ratio is displayed on the second monitor having the second aspect ratio at a correct aspect ratio.

In one aspect of this invention, the aspect ratio conversion section renders a blank portion resulting from the compression of the full image in the horizontal direction as a black image.

In one aspect of this invention, the first image includes a letterbox image including the first aspect. When the determination signal indicates the letterbox image, the aspect ratio conversion section converts the aspect ratio of the progressive scan video signal so that the letterbox image represented by the progressive scan video signal is extended in a vertical direction.

In one aspect of this invention, the second monitor having the second aspect ratio extends the letterbox image having the first aspect ratio in a horizontal direction by a factor of (M/N) where M and N are integers and M>N. The aspect ratio conversion section extends the letterbox image in a vertical direction by a factor of (M/N) so that the letterbox image having the first aspect ratio is displayed

on the second monitor having the second aspect ratio at a correct aspect ratio.

In one aspect of this invention, the letterbox image includes a subtitle displayed at an upper or lower portion of the letterbox image. The aspect ratio conversion section shifts the letterbox image represented by the progressive scan video signal so that the subtitle is prevented from disappearing from the second monitor having the second aspect ratio included in the progressive scan video monitor when the letterbox image is extended in the vertical direction.

In one aspect of this invention, the first aspect ratio is 4:3 and the second aspect ratio is 16:9.

In one aspect of this invention, the aspect ratio conversion section includes an aspect ratio conversion circuit for converting an aspect ratio of the progressive scan video signal and outputting the converted progressive scan video signal to the progressive scan video monitor, a designating section for designating the monitor information indicating the type of the progressive scan video monitor, and a control circuit for controlling the aspect ratio conversion circuit based on the determination signal and the monitor information designated by the designating section.

In one aspect of this invention, the conversion section includes an interlaced scan video signal reproduction section for reproducing the video signal as an interlaced scan video signal having 60 fields per second, an interlaced scanned aspect ratio conversion section for

converting an aspect ratio of the interlaced scan video signal reproduced by the interlaced scan video signal reproduction section, and a progressive scan video signal conversion section for converting the interlaced scan video signal, the aspect ratio of the interlaced scan video signal being converted by the interlaced scan video signal reproduction section, into the progressive scan video signal.

In one aspect of this invention, the conversion section further includes an interlaced scan designating section for designating interlaced scan monitor information indicating a type of the interlaced scan video monitor, and an interlaced scan control circuit for controlling the interlaced scan aspect ratio conversion section based on the determination signal and the interlaced scan monitor information designated by the interlaced scan designating section.

Thus, the invention described herein makes possible the advantages of providing (1) a video signal reproduction apparatus which can display an image at the correct aspect ratio in the case of all combinations of image sources having different aspects with monitors having different aspects; and (2) a video signal reproduction apparatus in which even when a 4:3 letterbox image includes a subtitle at a lower portion of a screen, the disappearance of the subtitle can be prevented.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure **1** is a block diagram showing a configuration of a video signal reproduction apparatus according to an example of the present invention.

Figure **2** is a schematic diagram showing the structure of a video signal recorded in a disk according to the example of the present invention.

Figure **3A** is a schematic signal diagram showing the type of a video signal according to the example of the present invention.

Figure **3B** is a schematic signal diagram showing the type of an interlaced scan video monitor according to the example of the present invention.

Figure **3C** is a schematic signal diagram showing the type of a progressive scan video monitor according to the example of the present invention.

Figure **4** is a schematic diagram for explaining the operation of an interlaced scan aspect ratio conversion circuit according to the example of the present invention.

Figures **5A** through **5C** are schematic diagrams for explaining a 4:3 full image displayed on an interlaced scan video monitor according to the example of the present invention.

Figures **6A** through **6D** are schematic diagrams for

explaining a 4:3 letterbox image displayed on an interlaced scan video monitor according to the example of the present invention.

Figures **7A** through **7C** are schematic diagrams for explaining a 16:9 image displayed on an interlaced scan video monitor according to the example of the present invention.

Figures **8A** through **8D** are schematic diagrams for explaining the operation of an aspect ratio conversion circuit according to the example of the present invention.

Figures **9A** through **9C** are schematic diagrams for explaining a 4:3 full image displayed on a progressive scan video monitor according to the example of the present invention.

Figures **10A** through **10F** are schematic diagrams for explaining a 4:3 letterbox image displayed on a progressive scan video monitor according to the example of the present invention.

Figures **11A** through **11C** are schematic diagrams for explaining a 16:9 image displayed on a progressive scan video monitor according to the example of the present invention.

Figure **12** is a block diagram showing a configuration of a conventional video signal reproducing apparatus.

Figure **13** is a schematic diagram showing the structure of a video signal recorded in a disk.

Figure **14A** is a schematic signal diagram showing the

type of a video signal.

Figure **14B** is a schematic signal diagram showing the type of an interlaced scan video monitor.

Figure **14C** is a schematic signal diagram showing the type of a progressive scan video monitor.

Figure **15** is a schematic diagram for explaining the operation of an interlaced scan aspect ratio conversion circuit.

Figures **16A** through **16C** are schematic diagrams for explaining a 4:3 full image displayed on an interlaced scan video monitor.

Figures **17A** through **17D** are schematic diagrams for explaining a 4:3 letterbox image displayed on an interlaced scan video monitor.

Figures **18A** through **18C** are schematic diagrams for explaining a 16:9 image displayed on an interlaced scan video monitor.

Figures **19A** through **19B** are schematic diagrams for explaining a 4:3 full image displayed on a progressive scan video monitor.

Figures **20A** through **20B** are schematic diagrams for explaining a 4:3 letterbox image displayed on a progressive scan video monitor.

Figures **21A** through **21C** are schematic diagrams for

explaining a 16:9 image displayed on a progressive scan video monitor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described by way of illustrative examples with reference to the accompanying drawings.

Figure **1** is a block diagram showing a configuration of a video signal reproducing apparatus **100** according to the present invention which reproduces an information signal recorded in a disk-type medium. The same parts as those of corresponding parts of the video signal reproducing apparatus **1200** of Figure **12** are referred to by the same reference characters. The description of these parts is thus omitted.

In Figure **1**, reference numeral **1** denotes a disk on which an information signal is recorded in an encoded and modulated signal form suitable for recording (or reproducing) in advance. The information signal includes a determination flag indicating the type of a video signal as well as a video signal.

The video signal reproducing apparatus **100** includes: a pickup **2** for transforming an information signal recorded on the disk **1** to an electrical signal; a disk rotating device **3** for rotating the disk **1** at a certain revolution-per-minute (rpm) suitable for the disk **1**; a material determination circuit **5** for determining the type of a video signal based on the determination flag included in the information signal; a conversion section **101** for

converting the electrical signal transformed by the pickup **2** to an interlaced scan video signal and a progressive scan video signal; an encoder **7** for converting the interlaced scan video signal into an NTSC video format and outputs the result through an interlaced scan video output terminal **8** to an interlaced scan video monitor **103**; and a color difference converter **10** for converting the progressive scan video signal output from the conversion section **101** into an analog color difference signal and outputs the result through a progressive scan video output terminal **11** to a progressive scan video monitor **104**.

The conversion section **101** includes: an interlaced scan video signal reproduction circuit **4** for demodulating and decoding the electrical signal output from the pickup **2** and outputting the resultant signal as an interlaced scan video signal; an interlaced scan aspect ratio conversion circuit **6** for converting the aspect ratio of the interlaced scan video signal and outputs the result; an interlaced scan aspect ratio designating section **13** which is used by a user to designate the aspect ratio of the interlaced scan video monitor **103**; an interlaced scan control circuit **12** for controlling the interlaced scan aspect ratio conversion circuit **6** based on the video signal type determined by the material determination circuit **5** and the type of the interlaced scan video monitor **103** designated by the interlaced scan designating section **13**, and a progressive scan video signal conversion circuit **9** for converting the interlaced scan video signal having the converted aspect ratio into a progressive scan video signal and outputting the result.

The video signal reproducing apparatus **100** further

includes: an aspect ratio conversion circuit **16** for converting the aspect ratio of a progressive scan video signal output from the progressive scan video signal conversion circuit **9** and outputting the result; a designating section **14** which is used by a user to designate the type of the progressive scan video monitor **104**, and a control circuit **15** for controlling the aspect ratio conversion circuit **16** based on the video signal type determined by the material determination circuit **5** and the type of the progressive scan video monitor **104** designated by the designating section **14**.

The operation of the thus-constructed video signal reproduction apparatus **100** of the present invention will be described with reference to Figures **1** through **11A-C**.

Figure **2** is a schematic diagram showing the structure of a video signal reproduced from the disk **1**. In an interlaced scan video signal, one field of image is created in 1/60 second. One frame of image is composed of two fields. The number of vertical pixels of each of the two fields is 240. The scan lines of the two field are alternately arranged. In other words, a pixel of one field is disposed between two adjacent pixels of the other field in the vertical direction. In a progressive scan video signal, one frame is created in 1/60 second and the number of pixels of one frame in the vertical direction is 480. Both have a vertical frequency of 1/60 second. The number of horizontal scan lines of the progressive scan video signal is twice as many as that of the interlaced scan video signal. The horizontal scan frequency of the interlaced scan video signal is about 15.75 KHz, while that of the progressive scan video signal is double, i.e., about 31.5 KHz.

Figure **3A** is a schematic signal diagram showing the structure of the video signal reproduced from the disk **1**. In the following examples, the aspect ratio of a video signal and the aspect ratios of an interlaced scan video monitor and a progressive scan video monitor all take the ratios 4:3 and/or 16:9. The present invention is not limited to these values. In the case of other aspect ratios, a ratio of length to width is only changed and similar functions and effects can be obtained

As shown in Figure **3A**, the video signal reproduced from the disk **1** has three forms. A first form of video signal represents an image having information which fills a full screen of 4:3 (hereinafter referred to as a 4:3 full image **301**). A second form of video signal represents an image of 16:9 in the middle of the 4:3 screen, the upper and lower portions of the screen being shaded (hereinafter referred to as a 4:3 letterbox image **302**). A third form of video signal represents an image having information which fills a full screen of 16:9 (hereinafter referred to as a 16:9 full image **303**).

Figure **3B** shows the aspect ratio of the interlaced scan video monitor **103**. As shown in Figure **3B**, there are two types of monitors for the interlaced scan video monitor **103**, one monitor **304** having an aspect ratio of 4:3 and the other monitor **305** having an aspect ratio of 16:9.

Figure **3C** shows the aspect ratio of the progressive scan video monitor **104**. As shown in Figure **3C**, there are two types of monitors for the progressive scan video monitor **104**, one monitor **306** having an aspect ratio of 4:3

and the other monitor **307** having an aspect ratio of 16:9.

The interlaced scan video signal reproduction circuit **4** reads a video signal recorded on the disk **1** from an output of the pickup **2**, reproduces an interlaced scan video signal, and outputs the result to the interlaced scan aspect ratio conversion circuit **6**. The material determination circuit **5** reads the determination flag from an output of the pickup **2**, determines the type of the video signal, and outputs the result as a determination signal to the interlaced scan control circuit **12**.

A user designates the type (aspect ratio) of the interlaced scan video monitor **103**, through which the user intends to output an interlaced scan video signal, using the interlaced scan aspect ratio designating section **13**. The interlaced scan control circuit **12** controls the interlaced scan aspect ratio conversion circuit **6** based on a determination signal output from the material determination circuit **5** and the type (aspect ratio) of the interlaced scan video monitor **103** designated by the interlaced scan aspect ratio designating section **13**.

Figure **4** is a schematic diagram for explaining the operation of the interlaced scan aspect ratio conversion circuit **6**. Assuming that the interlaced scan video monitor **103** has an aspect ratio of 4:3, the interlaced scan aspect ratio conversion circuit **6** has a function which compresses the 16:9 image **303** having an aspect ratio of 16:9 in the vertical direction. Specifically, in order to display the 16:9 image **303** on the 4:3 monitor **304** at the correct aspect ratio, 4 lines of information of an input video signal are subjected to a filtering process so that

3 lines of information are generated. Such a process is performed for the entire screen, so that the entire screen is compressed in the vertical direction. In this case, the displayed image has a correct aspect ratio (16:9), but leaving blanks in the upper and lower portions. Such portions are rendered black images. This aspect ratio conversion function can switch between a working state and a non-working state using the interlaced scan control circuit **12**. In the case of the non-working state, the interlaced scan aspect ratio conversion circuit **6** outputs a received interlaced scan video signal without the aspect ratio conversion.

In Figure **1**, the user designates as the aspect ratio of the 16:9 image **303**, through which the user intends to output an image, the monitor **304** having an aspect ratio of 4:3 or the monitor **305** having an aspect ratio of 16:9 using the interlaced scan aspect ratio designating section **13**. The material determination circuit **5** outputs the aspect ratio of an image source, i.e., one of the 4:3 full screen **301** or the 4:3 letterbox screen **302**, and the 16:9 screen **303**, to the interlaced scan control circuit **12**.

The interlaced scan control circuit **12** outputs the following three instructions to the interlaced aspect ratio conversion circuit **6**.

(1) The interlaced scan control circuit **12** outputs a first instruction which causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the non-working state when the material determination circuit **5** determines that the type of an image source is a 4:3 full image or a 4:3 letterbox image.

(2) The interlaced scan control circuit **12** outputs a second instruction which causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the non-working state when the material determination circuit **5** determines that the type of the image source is a 16:9 image and the interlaced scan aspect ratio designating section **13** designates as the type of an interlaced scan video monitor a 16:9 interlaced scan video monitor.

(3) The interlaced scan control circuit **12** outputs a third instruction which causes the aspect ratio conversion function of the interlaced scan aspect ratio conversion circuit **6** to be in the working state when the material determination circuit **5** determines that the type of the image source is a 16:9 image and the interlaced scan aspect ratio designating section **13** designates as an interlaced scan video monitor a 4:3 interlaced scan video monitor.

The encoder **7** converts an output of the interlaced scan aspect ratio conversion circuit **6** to the NTSC video format. The encoder **7** outputs an interlaced scanned image having the NTSC video format through the interlaced scanned image output terminal **8** to the interlaced scan video monitor **103**.

Figures **5A** through **5C** are schematic diagrams for explaining a 4:3 full image displayed on an interlaced scan video monitor. As shown in Figure **5A**, the 4:3 full image **301** displayed on the 4:3 interlaced scan video monitor**304** has the correct aspect ratio. However, a 4:3 full image **301A** displayed by the 16:9 interlaced scan video

monitor **305** does not have the correct aspect ratio, so that the displayed image is extended horizontally as shown in Figure **5B**. The 16:9 interlaced scan video monitor **305** includes a 4:3 output switch function since the standard aspect ratio of an interlaced scan video signal is 4:3. As shown in Figure **5C**, the 16:9 interlaced scan video monitor **305** can display a 4:3 full image **301B** having the correct 4:3 aspect ratio using the 4:3 output switch function.

Figures **6A** through **6D** are schematic diagrams for explaining a 4:3 letterbox image displayed on an interlaced scan video monitor. As shown in Figure **6A**, the 4:3 letterbox image **302** displayed on the 4:3 interlaced scan video monitor **304** has the correct aspect ratio. However, as shown in Figure **6B**, a 4:3 letterbox image **302A** displayed on the 16:9 interlaced scan video monitor **305** does not have the correct aspect ratio, so that the displayed image is extended horizontally. The interlaced scan video monitor includes a 4:3 letterbox image output switch function since the standard aspect ratio of interlaced scan video signal is 4:3. With the 4:3 letterbox output switch function, as shown in Figure **6C**, the 4:3 letterbox image **302A** is extended both upward and downward so that a 4:3 letterbox image **302B** fills the full screen. Therefore, the interlaced scan video monitor **305** can display a 4:3 letterbox image at a correct aspect ratio of 16:9. An image source may have subtitle information **302C** at the lower blank portion of an image. In this case, when a 4:3 letterbox image (**302A**) is extended upward and downward so that the 4:3 letterbox image (**302B**) fills a full screen and is displayed at a correct aspect ratio of 16:9, the subtitle information **302C** disappears. To avoid such a situation, the interlaced scan video

monitor **305** has a switch function with which the subtitle information **302** is shifted upward to be viewed on the screen.

Figures **7A** through **7C** are schematic diagrams for explaining a 16:9 image displayed on an interlaced scan video monitor. As shown in Figure **7A**, when a 16:9 image **303A** is displayed as it is on the 4:3 interlaced scan video monitor **304**, the image does not have the correct aspect ratio, such that the displayed image is extended vertically. However, if the user teaches the interlaced scan aspect ratio designating section **13** that an interlaced scan video monitor to be connected to the apparatus **100** is the 16:9 interlaced scan monitor **305**, the interlaced scan aspect ratio conversion circuit **6** is activated and the aspect ratio is converted so that an image (16:9 image **303B**) is correctly displayed as shown in Figure **7B**. In addition, as shown in Figure **7C**, the 16:9 interlaced scan video monitor **305** displays a 16:9 image **303** at a correct aspect ratio of 16:9.

Specifically, in the video signal reproduction apparatus **100**, the interlaced scan video monitor can display images having a correct aspect ratio in any combination of 3 types of image sources, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image with 2 types of video monitors, i.e., the 4:3 monitor and the 16:9 monitor.

An output of the interlaced scan aspect ratio conversion circuit **6** is input to the progressive scan video signal conversion circuit **9**. The progressive scan video signal conversion circuit **9** converts an input interlaced scan video signal to a progressive scan video signal, and outputs the result.

Figures **8A** through **8D** are schematic diagrams for explaining the operation of the aspect ratio conversion circuit **16** of the video signal reproduction apparatus **100** of the present invention.

Referring to Figure **8A**, the aspect ratio conversion circuit **16** has a horizontal aspect ratio conversion function which compresses the 4:3 full image **301** in the horizontal direction in order to display the 4:3 full image **301** on the 16:9 progressive scan video monitor **307** at the correct aspect ratio. Specifically, as shown in Figure **8A**, 4 pixels of information **81** included in the 4:3 full image **301** of an input progressive scan video signal are subjected to a filtering process so that 3 pixels of information **82** are generated. Such a process is performed for the entire 4:3 full image **301**, so that the entire 4:3 full image **301** is compressed in the horizontal direction. In this case, the 4:3 full image **301** is converted to a correct ratio of 4:3 on the 16:9 progressive scan video monitor **307**. However, the horizontal compression of the 4:3 full image **301** leaves blanks in the right and left portions. Such portions are rendered black images.

Referring to Figure **8B**, the aspect ratio conversion circuit **16** has a vertical aspect ratio conversion function which compresses the 4:3 letterbox image **302** in the vertical direction in order to display the 4:3 letterbox image **302** on the 16:9 progressive scan video monitor **307** at the correct aspect ratio. Specifically, as shown in Figure **8B**, 3 pixels of information **83** included in the 4:3 letterbox image **302** of an input progressive scan video signal are subjected to a filtering process so that 4 pixels of information **84** are

generated. Such a process is performed for the entire 4:3 letterbox image **302**, so that the entire 4:3 letterbox image **302** is expanded in the vertical direction, whereby the 4:3 letterbox image **302** is converted into the 16:9 screen.

As shown in Figure **8C**, the aspect ratio conversion circuit **16** has a vertical display position shift function with which after the 4:3 letterbox image **801** is extended in the vertical direction, the extended 4:3 letterbox image **801** is shifted so that a vertical center position **803** of the 4:3 letterbox image **801** is moved to a center position **804** (by a predetermined amount upward). This function is realized by changing the position of a display image signal with respect to a vertical synchronization signal.

These three aspect ratio conversion functions each can select a working or non-working state using the control circuit **15**. When all of the conversion functions are in the non-working state, the aspect ratio conversion circuit **16** outputs an input progressive scan video signal without an aspect ratio conversion.

In Figure **1**, the user designates as the type of the interlaced scan video monitor **103** for display the 4:3 interlaced scanned video monitor **304** or the 16:9 interlaced scanned video monitor **305** using the interlaced scan aspect ratio designating section **13**. The user also designates in the designating section **14** whether the type of the progressive scan video monitor **104** is the 4:3 progressive scanned video monitor **306** or the 16:9 progressive scanned video monitor **307** and whether or not the vertical display

position shift is executed. On the other hand, the material determination circuit **5** outputs the type of the image source, i.e., one of the 4:3 full image **301**, the 4:3 letterbox image **302**, and the 16:9 image **303**, to the interlaced scan control circuit **12** and the control circuit **15**.

The control circuit **15** outputs the following five instructions to the aspect ratio conversion circuit **16**.

(1) The control circuit **15** causes both the horizontal and vertical aspect ratio conversion functions and the vertical display position shifting function of the aspect ratio conversion circuit **16** to be in the non-working state when the material determination circuit **5** determines that the aspect ratio of the image source is the 4:3 full image **301** or the 4:3 letterbox image **302** and the type of the progressive scan video monitor **104** designated by the designating section **14** is the 4:3 progressive scan video monitor **306**.

(2) The control circuit **15** causes the horizontal and vertical aspect ratio conversion functions of the aspect ratio conversion circuit **16** to be in the working state and in the non-working state, respectively, when the material determination circuit **5** determines that the aspect ratio of the image source is the 4:3 full image **301** and the type of the progressive scan video monitor **104** designated by the designating section **14** is the 16:9 progressive scan video monitor **307**.

(3) The control circuit **15** causes the vertical and horizontal aspect ratio conversion functions and the vertical display position shifting function of the aspect

ratio conversion circuit **16** to be in the working state, in the non-working state, and in the non-working state, respectively, when the material determination circuit **5** determines that the aspect ratio of the image source is the 4:3 letterbox image **302**, the type of the progressive scan video monitor **104** designated by the designating section **14** is the 16:9 progressive scan video monitor **307**, and the vertical position shift is not set in the designating section **14**.

(4) The control circuit **15** causes the vertical aspect ratio conversion function and the vertical display position shifting function of the aspect ratio conversion circuit **314** to be in the working state and causes the horizontal aspect ratio conversion function of the aspect ratio conversion circuit **314** to be in the non-working state when the material determination circuit **5** determines that the aspect ratio of the image source is the 4:3 full image **301** or the 4:3 letterbox image **302**, the type of the progressive scan video monitor **104** designated by the designating section **14** is the 16:9 progressive scan video monitor **307**, and the vertical position shift is set in the designating section **14**.

(5) The control circuit **15** causes both the horizontal and vertical aspect ratio conversion functions and the vertical display position shifting function of the aspect ratio conversion circuit **16** to be in the non-working state when the material determination circuit **5** determines that the aspect ratio of the image source is the 16:9 image **303**.

The color difference converter **10** converts a

progressive scan video signal to a color difference video signal, and outputs the color difference video signal through the progressive scanned image output terminal **11** to the progressive scan video monitor **104**.

Figures **9A** through **9C** are schematic diagrams for explaining a 4:3 full image displayed on a progressive scan video monitor. As shown in Figure **9A**, a 4:3 full image **301** displayed on the 4:3 progressive scanned video monitor **306** has the correct ratio. However, a 4:3 full image **301D** displayed on the 16:9 progressive scanned video monitor **307** does not have the correct ratio, so that the displayed image is extended horizontally. The progressive scan video monitor **307** has a 4:3 output switch function since the standard aspect ratio of progressive scan video signal is 4:3. With the 4:3 output switch function, as shown in Figure **9C**, a 4:3 full image **301E** is displayed at a correct aspect ratio of 4:3.

Figures **10A** through **10F** are schematic diagrams for explaining a 4:3 letterbox image displayed on a progressive scan video monitor. As shown in Figure **10A**, a 4:3 letterbox image **302** displayed on the 4:3 progressive scan video monitor **306** has the correct aspect ratio. As shown in Figure **10B**, however, a 4:3 letterbox image **302E** displayed on the 16:9 progressive scan video monitor **307** does not have the correct aspect ratio, so that the displayed image is extended horizontally. The progressive scan video monitor has a 4:3 letterbox image output switch function since the standard aspect ratio of a progressive scan video signal is 4:3. With the 4:3 letterbox output switch function, as shown in Figure **10C**, the 4:3 letterbox image is extended both upward and downward so that a 4:3 letterbox image **302F**

fills the full screen. Therefore, the progressive scan video monitor **306** can display a 4:3 letterbox image at a correct aspect ratio of 16:9.

As shown in Figure **10D**, some image sources may have subtitle information **302H** at the lower blank portion of an image. In this case, as shown in Figure **10E**, when a 4:3 letterbox image **302G** is extended upward and downward, the subtitle information **302C** at the lower blank portion of the 4:3 letterbox image **302G** disappears. In this case, the designating section **14** designates the vertical display position shift. Therefore, as shown in Figure **10F**, the aspect ratio conversion circuit **16** shifts the 4:3 letterbox image **302G** upward so that the subtitle information **302H** can be viewed in the 16:9 progressive scan video monitor **307**.

Figures **11A** through **11C** are schematic diagrams for explaining a 16:9 image output on a progressive scan video monitor. As shown in Figure **11A**, a 16:9 image **303F** displayed on the 4:3 progressive scan video monitor **306** does not have the correct aspect ratio, so that the displayed image is extended vertically. However, if the user teaches the designating section **14** that a progressive scan monitor to be connected to the apparatus **100** is the 16:9 progressive scan monitor **307**, the aspect ratio conversion circuit **16** is activated and the aspect ratio is converted so that a 16:9 image **303G** is correctly displayed as shown in Figure **11B**. In addition, as shown in Figure **11C**, the 16:9 progressive scan video monitor **307** displays a 16:9 image **303** at a correct aspect ratio of 16:9.

As described above, in the video signal reproduction apparatus **100** of the present invention, the progressive

scan video monitor **104** can display images at corresponding correct aspect ratios in any combination of the image sources of the 4:3 full image **301**, the 4:3 letterbox image **302**, and the 16:9 image **303** with the 4:3 progressive scan video monitor **306** and the 16:9 progressive scanned image monitor **307**. Further, for the 4:3 letterbox image **302G** having a subtitle at the lower blank portion of a screen, the disappearance of the subtitle can be prevented.

Note that, in the example, the image sources are limited to the 3 types, i.e., the 4:3 full image, the 4:3 letterbox image, and the 16:9 image. However, there may be four or more image sources. In the example, two aspect ratios, i.e., 4:3 and 16:9 are used. If the aspect ratio conversion function of the aspect ratio conversion circuit is changed in accordance with the aspect ratios of the image source, the aspect ratio is not limited to two. The present invention can be applied to a case where three or more aspect ratios are used.

Further, in Figure **1**, each component, i.e., the material determination circuit **5**, the aspect ratio conversion section **102**, the encoder **7**, and the color difference converter **10**, are in the form of hardware such as a circuit, but may be replaced with software.

The aspect ratio conversion circuit **16** can shift an image display position upward by a predetermined number of lines. Alternatively, the number of lines by which the image display position is shifted may be variable so that the amount of the upward shift can be changed.

Further, in the examples, the description is given

of a video signal recorded on a disk medium. The present invention can also be applied to a video signal recorded in tape media and a video signal included in an information signal transmitted by satellite broadcast, ground-wave broadcast, or the like.

As described above, according to the present invention, a video signal reproduction apparatus is provided in which images can be displayed at corresponding correct aspect ratios in any combination of image sources having different aspect ratios with monitors having different aspect ratios.

Further, according to the present invention, a video signal reproduction apparatus is provided in which when a 4:3 letterbox image has a subtitle at the lower blank portion of a screen, the disappearance of the subtitle can be prevented.

Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.